HUMIC ACID REMOVAL FROM SURFACE WATER USING UTRAFILTRATION MEMBRANE

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Abstract
The main focus of research was to purify surface water with ultrafiltration, so it could be used as a source of drinking water. By measuring individual parameters and performing physical and chemical analysis, we determined the influence of natural organic matter (NOM) and checked the membrane fouling. The operation of the membrane was carried out at various transmembrane pressures (*TMp*) (2, 3 and 4 bar).
Purification with UF was carried out on the Memcell device with regenerated cellulose membrane type NADIR® PM UC030 with NMWCO of 30 kDa. With increasing pressure, the quality of the purified water increased. At 4 bars, the COD was totally removed from the Mura river sample.

Introduction
Characterisation and understanding of fouling layer, play most important role in the design of pre-treatment as well as impact the membrane cleaning protocol. [1] The UF membranes were studied for gathering drinking water from river water. UF with 300 to 2000 Da were tested. Removal of NOM depend on TMP, material, pore size of membrane, and Ca content. [2] COD_{Mn} was lowered by 31 to 42%, DOC from 42 to 47% by treating surface water. Coagulation was perfect for improvement of fouling and flux increase. [3]
The NOM removal from river water was studied. Certain analytical parameters were measured, such as concentration of humic acid, chemical oxygen demand (COD), temperature and conductivity, in river water and permeate.

Experimental
Membrane used was made from regenerated cellulose (NADIR® PM UC030) with NMWCO of 30 kDa, Support material was non-woven polyester. Characteristic pH range was 2-11 and temperature 5-55 C.
pH was determined by WTW pH meter and water conductivity was measured using WTW Conductometer. The concentration of humic acid was measured at 254 nm using spectrophotometer. The calibration curve is seen from Figure 1. The concentration of humic acid was calculated from presented curve.

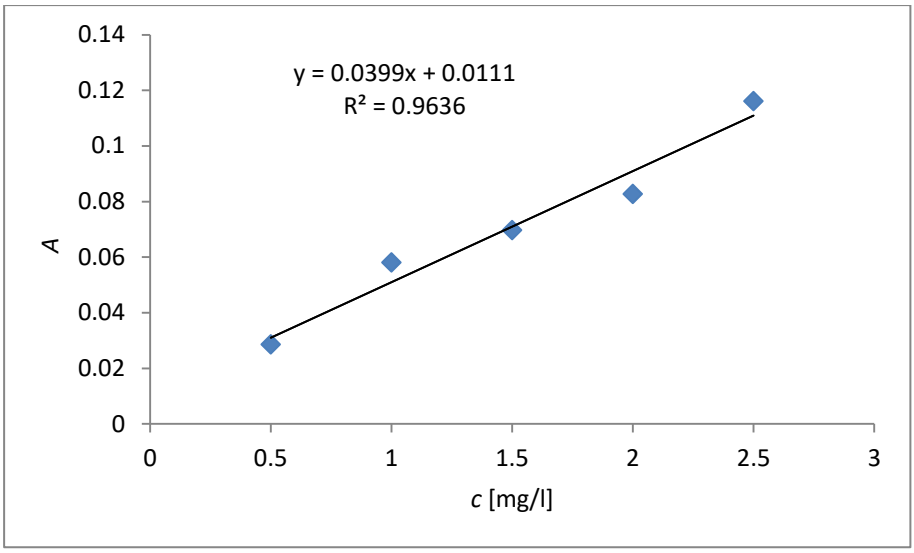

Figure 1: Calibration curve for humic acid detemination

Filtration was performed on Memcell apparatus, shown in Figure 2. Water circulated through the system, permeate samples were taken and concentrate was recycled back into the feed reservoir.

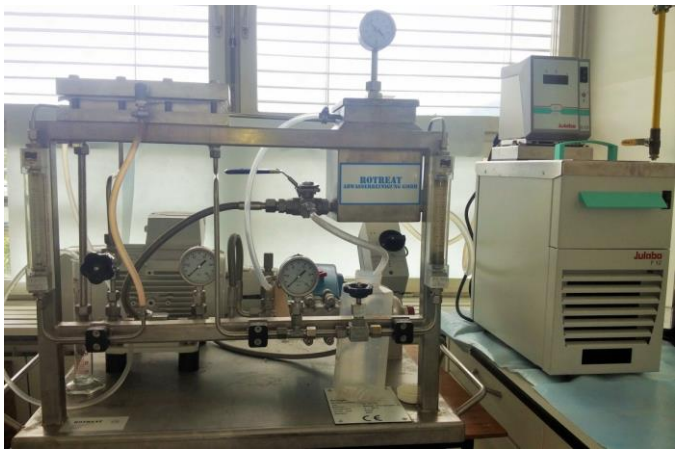

Figure 2: Memcell UF unit

Firstly, the permeability of membrane was determined. Then, four samples of surface water from the Mura and three from Drava river were taken. UF was performed at various transmembrane pressures (*TMp*) ranging from 2 to 4 bar at room temperature and original pH.

Results and discussion

The rate of water flow through the membrane was proportional to the TMP. Permeability was determined at 1.5 L/min.m^2.bar as seen from Figure 3. The flux was the same as the TMP was increased from 8 to 10 bars. However, producer recommendation for TMP was up to 6 bar, therefore TMPs from 2-4 bars were chosen for further analyses.

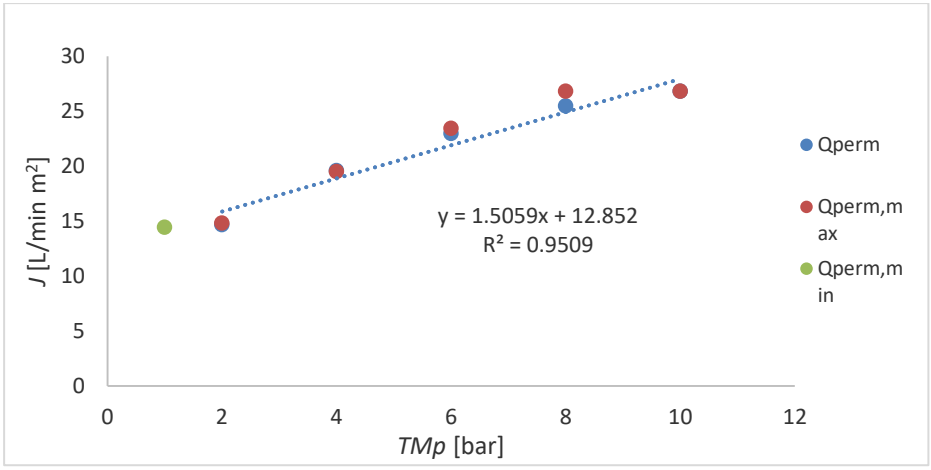

Figure 3: Membrane permeability

It was found that the pressure does not have an effect on the permeate flow, since during the UF process, regardless of the pressure, the decrease due to the formation of the filter cake, was similar. The results are presented in Figure 4. After half an hour of operation, the water flow reached the value around 11 ml/min for all tested water samples. The results at lower TMP were very similar, reaching steady state flow at 10 ml/min.

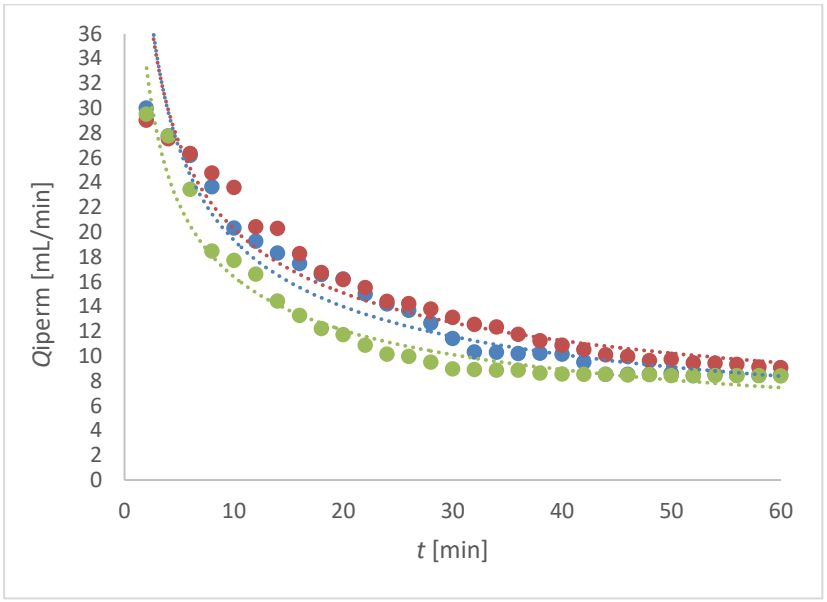

Figure 4: Water flux for Mura river permeate samples (different colour means different sample)

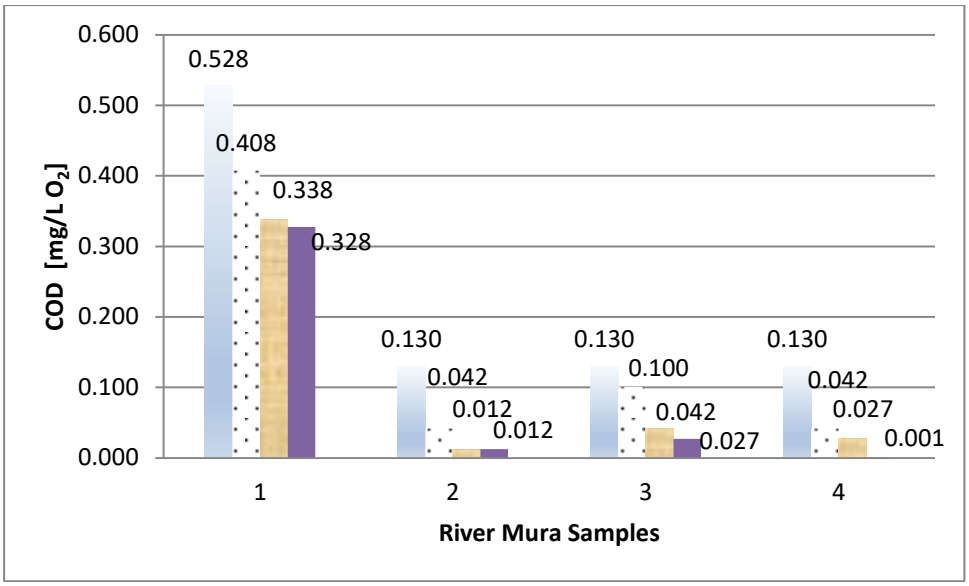

Figure 3: COD in Mura river samples: first column represents river water, second UF permeate at 2 bar, third after 3 bar and fourth after 4 bar

By increasing the pressure, the COD and the NOM content decreased. At the highest TMP at 4 bar, the highest decrease of COD was obtained, up to 99 % in case in the fourth sample. If the COD was higher in untreated water, the removal efficiency was lower.
Results of measurement of humic acid concentration showed the decrease at all TMPs. The optimal removal was 70 % in fourth sample at 4 bar. If the initial concentration of humic acid was higher, the removal was lower.
The limiting factor of UF systems is fouling which is defined as the precipitation of solutes in the form of a cake layer on the surface of the membrane. From Figure 4 it is seen that the cake layer forms in accordance with another study [4].

Conclusion

Tested membrane successfully removed humic acid from river water. The best removal was achieved in Mura river sample at 99 %. The limiting factor of UF systems is fouling which is defined as the precipitation of solutes in the form of a cake layer on the surface of the membrane. General parameters, such as pH, conductivity and temperature did not vary.

Acknowledgements

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